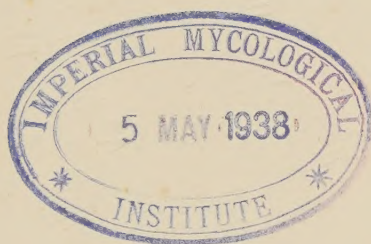


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Forty-Second Annual Report

OF THE

Agricultural
Experiment Station

OF THE

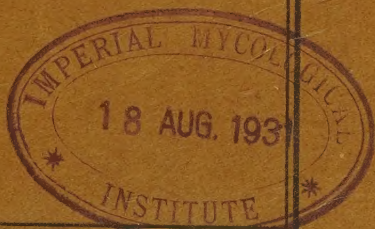
University of Kentucky
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Bulletins 291-298



1929





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FORTY-SECOND ANNUAL REPORT

OF THE

Agricultural Experiment Station

OF THE

University of Kentucky

FOR THE YEAR 1929



Part I.

Report of the Director

Meteorological Summaries

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LETTER OF TRANSMITTAL

To His Excellency, Hon. Flem D. Sampson, Governor of Kentucky:

Sir:—In accordance with an act of Congress, approved March 2, 1887, entitled, "An Act to establish Agricultural Experiment Stations, in connection with the Agricultural Colleges established in the several states under the provisions of an act approved July 2, 1862, and under the acts supplementary thereto," and of the act of the Legislature of the State of Kentucky, approved February 20, 1888, entitled, "An Act to accept the provisions of an act passed by the Congress of the United States, approved March 2, 1887, for the establishment and maintenance of Agricultural Experiment Stations in connection with Agricultural Colleges established by the several states and territories under an act of Congress approved July 2, 1862," I herewith submit the Forty-second Annual Report of the Kentucky Agricultural Experiment Station.

Very respectfully,

THOMAS P. COOPER, *Director.*

January 1, 1930.

ANNUAL REPORT
of the
DIRECTOR OF THE
KENTUCKY AGRICULTURAL EXPERIMENT STATION
For the Year 1929

The Experiment Station is organized as a fact-finding institution. Its primary purpose is to acquire knowledge and information that will be useful to agriculture. Evidence is abundant that from year to year farmers of the state are making greater use of the results obtained at the Station, and that the changes taking place in the state are slowly placing agriculture in a better position.

The wide diversity of products and conditions in the state requires corresponding diversity in research activities. The Station enlarges its research facilities as means permit, to meet the problems evident or developing in the state. Increased financial support would bring to the state increased results that would return annually many times the cost of the investigations.

The Experiment Station has steadily increased its range of usefulness. Thru its substations in western and eastern Kentucky, it is enabled to conduct investigations more closely related to the soil and climatic conditions in the sections served. The substations are proving particularly valuable in affording opportunity for the study of soil and crop problems. The Western Kentucky Substation now conducts soil fertility investigations on more than 630 plots. In addition, the investigations of pasture crops and usage, of small fruits, of orchards and of farm practice in relation to dairying and poultry, furnish a large amount of information applicable to the western section of the state.

In the past two years, research has expanded particularly in the field of home economics and of economics as applied to agriculture. Each field of study offers many opportunities. Included in this report is a brief review of the more important results that have been obtained.

The various regulatory and service functions performed thru the Experiment Station are growing from year to year. The public service laboratories continue to carry a large amount of work, rendering service of great value to every section of the state. It is of interest that during the past year every county has been served. If the value of these services were calculated at a conservative commercial figure, they would represent at least fifteen times the annual appropriation allotted for this work. Thru such laws as the commercial feeding stuffs act, the commercial fertilizer act, the nursery inspection act, the creamery license act and similar regulatory acts, the Experiment Station is enabled to educate both the manufacturer and the farmer as to higher standards. These various acts are considered largely from their educational aspects, altho occasionally court proceedings are required to protect against adulteration and fraud.

The report of the research and varied activities of the Experiment Station is necessarily brief and incomplete. As research problems progress or are completed, they are published in the form of bulletins and scientific papers which may be obtained upon request.

Grading Tobacco. In cooperation with the United States Department of Agriculture, an official tobacco grading service was established at two Kentucky markets during the past year. This service consisted in placing a grader on the warehouse floor to examine tobacco at the request of the farmers and place upon it an official government grade. This grade is called to the buyers when the sale is started and makes possible market quotations by grades. This service in markets where tried has proved beneficial to both buyers and sellers.

Other work conducted on tobacco has been largely statistical in character. The aim has been to study the factors affecting the price of tobacco and special emphasis has been given to burley. A preliminary study of data available suggests that four factors are of major importance in determining prices, namely, the size of the crop in relation to annual requirements, the size of storage stocks in relation to annual requirements, the quality

of the crop, and the general price level. Data have been assembled on each of these factors.

A comparison of several indexes of general prices has been made in different combinations for the purpose of finding the one best adapted to a study of tobacco prices. Because tobacco is grown in one year and marketed to a great extent during the early months of the following year, this problem differs from that of many other commodities.

Marked changes in prices during the burley marketing season last year have stimulated interest in seasonal price changes of tobacco. Preliminary work on this phase of tobacco prices has been done. A study of weekly average prices for the Lexington market indicates a tendency for average prices to rise during the first part of the marketing season and to fall late in the season. Market averages, however, are not a good measure of actual market conditions because all grades are thrown together. Therefore, the seasonal price movements may be due to seasonal variations in average quality. It is hoped that the grading experiments will furnish data from which seasonal prices by grades may be studied.

Changes in the size of the burley crop are due to changes in acreage and changes in the yield per acre. Apparently about three-fourths of the change in production from one year to the next has been due to changes in acreage, while about one-fourth has been due to changes in yield per acre. Variations in yield are due to many causes chief among which probably are weather conditions during the growing season. Changes in acreage are affected materially by the change in price the preceding year. Eleven times during the last sixteen years a rise or fall in burley prices has been followed by a similar change in acreage the following year. A large change in price usually has been followed by a large change in acreage.

In price studies the problem frequently arises as to whether or not the total value of a crop increases or decreases with its size. For some crops, it has been shown conclusively that within the usual limits of variation, the smaller the crop the greater the

total value and vice versa. According to the present study, in burley tobacco the relationship is not constant. Studies under way will attempt to determine the relationship if any.

The size of storage stocks in relation to annual requirements is important and differs in different types of tobacco. Stocks of burley on October 1, during the past 17 years, have averaged about 16 percent greater than disappearance during the corresponding years. Stocks of Kentucky and Tennessee dark-fired tobacco and one-sucker tobacco have averaged 5 percent and 10 percent, respectively, less than annual requirements. Stocks of the Green River and Henderson types combined, have averaged 20 percent less than annual disappearance during the same period. Data for the last two types are given separately only since 1923. In these six years, stocks of the Henderson type have averaged 46 percent less than disappearance while Green River stocks averaged 25 percent more. These variations are significant when considering what "normal" stocks should be.

Cooperative Marketing and Purchasing in Kentucky. This study has been confined largely to cooperative strawberry marketing associations. There are ten associations in Kentucky. These have a common interest because the Aroma variety of strawberry is produced by all their members. During the last few years prices have been discouraging to strawberry growers, with the result that production has declined and marketing associations are finding it more difficult to meet overhead expenses. In view of these facts, a study was undertaken to learn something of operating methods and costs so that assistance could be rendered to these associations. Each association was visited and data were obtained concerning volume of business, organization set-up, operating methods and costs of operation. Several significant conclusions have been drawn from the study.

Labor costs accounted for about two-thirds of the total expenses of the associations in 1929. This important item, as well as total costs was affected materially by the size of the business and by the method of paying the manager. Method of hiring labor also had some effect. The volume of business of the ten associations in 1929 ranged from 10 to 372 carloads, and total

cost of operation from \$23.65 to \$128.58 per car. The largest association was not the lowest in cost, however, because of other factors.

Three general methods of paying association managers were used. Some were paid a stated salary for the season, others, a flat rate per crate for all berries handled thru the association, while still others were paid a percentage of net returns received for berries sold. Under the first method, the manager's salary remains the same, even with fluctuating volume of business, so that small volume is apt to result in high unit cost for management. The third method has the advantage of permitting management cost to fluctuate somewhat with net return to growers and it encourages thrift and efficiency on the part of the manager. A scaling down of the percentage paid as the volume increases probably should be provided for in large associations.

Returns to strawberry growers are made thru seasonal pools, daily pools or car pools. Wide variations in prices within the shipping season suggest that the seasonal pool may furnish a less equitable basis of distribution than the other types. On the other hand, wide variation in price received for berries of equal quality sold on the same day but shipped to different markets, indicates that the use of a car pool results in wide discrepancies between growers. Altho slightly more bookkeeping is required for the daily pool, this method seems best fitted to Kentucky conditions.

The strawberry associations have many problems in common and the matter of establishing a central association to look after mutual interests merits careful consideration. Among the matters to which such a central body could give attention are better cultural and handling practices, the interchange of information, finding and developing new markets, routing consignments, supervising sales, and handling transportation problems. Greater uniformity in packing and grading berries also should be possible as a result of centralized supervision. An analysis of each year's business could be made by a central organization, for the purpose of discovering mistakes which have been made.

of studying new tendencies in distribution and considering price and acreage prospects for the coming season. Kentucky managers have met several times for the discussion of mutual problems. It is possible that similar meetings to which association directors, also, are invited would prove beneficial to all concerned. As Kentucky ranks ninth among the strawberry states in the number of carloads shipped, unified action by helping to meet the competition of other producing areas, may improve her standing.

Livestock Marketing. Several significant conclusions have been reached in the study of quality as a factor in the price of Kentucky lambs. (1) Quality is an important factor. Sex, weight, conformation and finish are the principal characteristics that are given consideration. Ewe and wether lambs are generally given preference over ewe and buck lambs and the discrimination against bucks would doubtless be more apparent if buck lambs were sold separately. Medium-weight lambs generally command a premium over those of light or heavy weight. Likewise lambs with broad, deep, medium-length bodies, well-developed legs and finished with a good covering of fat, sell for best prices. Expressed in terms of market grades, best prices are generally paid for prime and choice lambs, either ewe or wether, weighing from 70 to 80 pounds.

(2) High-quality lambs not only command a premium under ordinary marketing conditions, but also sell at relatively better prices than low-quality lambs as a marketing season advances. The premium paid for ewe and wether lambs as well as for high-grade lambs is much larger toward the close of a marketing season than at the beginning. These are very significant facts for Kentucky lamb producers because they emphasize the importance not only of producing lambs for the early market, when high-quality lambs can be produced to the best advantage in Kentucky, but also of adopting good flock practices when producing lambs for the late market.

(3) Prices paid for lambs are related to quality characteristics in varying degrees at different markets. This situation

may be accounted for in part by the difference in importance which buyers in different markets attach to the same quality factors. However, since most Kentucky lambs are destined for the same consumer market, it is probable that the chief reason for variation is in selling practices. Different marketing agencies, including traders, auction companies and commission dealers, follow different market policies in sorting and grouping lambs for sale.

(4) The foregoing conclusion shows that different lamb markets function with different degrees of efficiency in reflecting consumer preference for lambs and in thus functioning to direct and control lamb production. The importance of markets organized to establish prices which accurately reflect commercial value does not need emphasis. Accurate reflection of quality in price is advantageous to lamb producers because it not only indicates consumer market requirements, but also compensates for care and expense where additional effort and outlay are incurred in producing particular qualities; to consumers because they can be assured of a supply of lamb having the qualities demanded, and to dealers because an important source of criticism is thus eliminated. A market which has such an organization receives its share of lambs of different qualities.

(5) Developments in two directions will greatly improve the efficiency of lamb markets in establishing prices that reflect quality. The first is the establishment of a satisfactory set of grades. Livestock exchanges in various markets have developed grades for lambs. Recently the United States Department of Agriculture has promulgated federal grades. But these different grade systems have not gained general recognition by livestock traders and have been used chiefly for quotations. The second is the observance of market grades by all livestock marketing agencies engaged in lamb marketing. There are practical limits to the number of grades that can be used in individual markets. Large volume permits more grades than small volume. Markets with abundant facilities can sort and grade in recognition of a wider range of quality than those whose stockyard equipment is limited. On the other hand, many Kentucky mark-

ets could sort and grade livestock for sale better than at present, without appreciable increase in cost or serious impairment of efficiency. Insistence of livestock producers for this service and a willingness of dealers to give it usually would assure better sorting and grading. When farmers and dealers accept grades and adjust their marketing practices to a grading system, the livestock market system will function much better in establishing prices that relate more closely to quality. Its influence in directing and controlling production will accordingly be much more effective.

Economic and Social Conditions on Eastern Kentucky Mountain Farms. This study included all the families in a representative area of Laurel County containing 203 farms. The average size of the farms was 76 acres, of the families, 5.3 persons. The average total cash income of the families was \$436 for the year. Operators who depended mainly on the operation of the farm for a livelihood derived a net income from the farm averaging \$283. The most profitable farms had nearly double the crop acreage of the least profitable farms. They had more dairy cattle and poultry. The net returns from dairying were nearly double and the net returns from poultry more than double those on the least profitable farms. The most profitable farms have about ten times the acreage of tobacco and truck crops as the least profitable farms, and secured considerably better crop yields.

The study furnished strong evidence that soil improvement is one of the most vital factors for increasing farm profits and bettering living conditions in this area. The use of limestone and phosphate and the control of erosion appeared to be the chief factors in an effective program of soil improvement. The average expenditure for limestone on the most profitable farms was about three times the average on all farms. The chief factor in protecting the soil from erosion was the use of grass and sod crops on the sloping land, and a necessary feature of such a system was the use of grass-eating livestock. Successful grass production was found to depend generally upon liming

and phosphating the land and control of the growth of shrubs and sprouts which choke the grass on the pasture and hay fields.

Operators who derived a large proportion of their total business income from work other than farming secured, on the average, \$177 greater labor income for their year's work than those who derived nearly all from farming. This raises the question of whether farmers in this area must of necessity look to outside work in order to piece out an adequate farm income or whether it is within their power to make changes in their farming and livestock systems that will afford adequate incomes without having to resort to outside work. The study shows that an adequate income from farming in this area depends largely upon a sufficiently large business, and the inclusion of relatively intensive enterprises such as dairying, tobacco production, and poultry. Forty farms, with crop areas between 30 and 45 acres, provided 163 days of productive work per man and gave operator's earnings averaging \$518; 18 farms, with more than 45 acres in crops, provided 194 days of productive work per man and gave operator's earnings of \$760. These figures point strongly to the conclusion that the operation of farms which have a sufficient area of crop land and are so organized as to provide a reasonably full year's work for the operator and his family, compares favorably as a means of livelihood, or may be superior to, an occupation which includes non-farming work as a chief source of income of farm occupants.

Farm Organization and Management. One important part of these studies was the accumulation of further data on the labor and power requirements and other requirements per unit of crops and livestock. Another was the working out of combinations of crops and livestock which represent the most profitable systems of farming in the principal areas of the state. The completion of work along this line in the Purchase Region was marked by the publication of two bulletins, one entitled *An economic study of crops and livestock in the Purchase Region of Kentucky*, and the other, *Systems of farming for the Purchase Region*. The latter presents detailed budgets of crops, livestock, receipts, expenses and net income for farms of various sizes and

types. Work was prosecuted on similar budgets for the south central, central, northern and eastern Kentucky areas.

A study of farm organization was begun in Grayson County during the past summer. Financial records of 205 farms were analyzed. The operators with the larger acreages secured larger net earnings than those with the smaller acreages. There was a considerably smaller chance for a farmer to secure good net returns on a small acreage than on a good sized acreage. Of 26 operators who worked 20 acres or less of crops, three, or about one-ninth, made net earnings of \$500 or more; of 21 operators who worked 80 or more crop acres, eleven, or more than half, made net earnings of \$500 or more. Other factors underlying profitable farming are being disclosed by the analysis of the data of this study.

Incomes and Costs of Living of Farm Families. Studies of the cost of living in relation to farm income were made in two areas, one in Taylor, Green and Adair Counties, the other in Grayson County. In the former area, 429 yearly financial records were analyzed, and 142 in the latter, the data being taken from book records kept by farmers under the supervision of the department of farm economics. The average investment was \$7,411 and the average size of these farms 126 acres. Material for a Station bulletin was obtained.

Farm Tenancy. The data gathered in several years of study of this problem have been analyzed and a report completed for publication.

The net return of landlords on the capital invested was 16 percent in 1927, 8 percent in 1926, 13 percent in 1924, and 12.2 percent as the average for the three years. The average total investment per tenant-operated tract was \$10,414 and the income after taxes and other expenses were deducted was \$1669 in 1927, \$823 in 1926, and \$1376 in 1924. The net income for the three years averaged \$1268, or \$26 per acre on tracts averaging 49 acres.

The chief factors determining the profits of tenants of burley tobacco farms were (1) large returns from tobacco; (2) a "good show," and (3) thrift in the use of funds and time.

There was a wide variation in receipts from year to year. The figures show the hazard of the tobacco crop from the standpoint of a steady income. One protection for a grower against the hazard of a low income in any one year is for him to carry on other crop or livestock enterprises. An alternative would be to follow a definite policy of saving a sufficient part of the income when tobacco sells at a high price to tide over periods when the crop sells at a low price.

The tenant who cultivates excellent tobacco land and who is an exceptionally skillful raiser and handler of tobacco may make more money by raising the maximum acreage of tobacco to the exclusion of other enterprises, but this is not the case with the average tenant cultivating average tobacco land.

Methods of Topping and Suckering Tobacco. The first year's results showed surprisingly large differences in yield from the different methods, as well as marked differences in quality of the cured leaf. Tobacco topped early, as soon as the bud appeared, and kept closely suckered thruout the season, yielded approximately 30 percent more than the average yield where the so-called labor-saving practices were followed. The most common of these, that of permitting one or two top suckers to grow, seemed to save little labor, but did give an exceptionally good quality of leaf. Late topping and delaying the removal of suckers saved much labor and gave about as good yield and as good quality as where two suckers were left. Tobacco not topped or suckered until harvest gave low yields and a rather large percentage of inferior leaf. In spite of the much larger yield from the early topped, closely suckered tobacco, the net acre returns were little or no better than from the tobacco that was topped late and suckered but once, or from that where two suckers were allowed to grow. The heavy yield was associated with a dark colored leaf, so that the price per pound averaged about 5 cents less than for the other tobacco.

Mulch Paper on Tobacco. Mulch paper did not prove of apparent benefit to tobacco. The unmulched plots made as quick

and as large a growth as the mulched, and the quality of the two tracts was no better from the mulched plots.

Frenching of Tobacco. Work in the greenhouse has confirmed the field observations that liming on certain of the soil experiment fields induces frenching of tobacco. Turkish tobacco has invariably frenched when grown in soil from the lime alone and lime and superphosphate plots of the Campbellsville and Greenville experiment fields. Frenching has not occurred in soil from the unlimed plots. With the pH of the culture medium between 5 and 6, frenching has not appeared in Turkish tobacco, in sand or water cultures in the greenhouse, with deficient supplies of either nitrogen, phosphorus, magnesium or iron.

Tobacco and Potato Virus Diseases. It was again found that by requiring the men to wash their hands with soap and water before beginning to pull tobacco plants and by requiring those who chew tobacco to use sterilized tobacco instead of the natural leaf commonly used, mosaic could be controlled. Handling the dry natural leaf tobacco and wiping the mouth while chewing, results in the hands becoming contaminated with the mosaic virus. In 30,000 plants under observation, only three developed mosaic following setting, and very few more had developed by topping time. Two of the plots used had been planted to tobacco consecutively for more than 12 or 20 years, respectively.

A study of what is considered to be rugose mosaic of Irish Cobbler potatoes indicates that two viruses are concerned in the problem. One of these, the "healthy potato" virus, is always present in this variety. The other virus is one commonly found in tobacco growing where potatoes have been grown. It causes veinbanding. A mixture of these viruses causes a severe necrotic disease of tobacco identical with that produced when tobacco is inoculated directly from mosaic potatoes. Cobbler potatoes inoculated with the veinbanding virus develop a severe necrotic disease which usually results in the death of the plant. Seeding potatoes inoculated with the "healthy potato" virus and the veinbanding virus, develop a similar disease. Plants

from tubers of the inoculated plants develop typical rugose mosaic in both cases.

Veinbanding etch, etch+, and severe etch, each produces a disease of seedling potatoes characterized by faint mottling and rugoseness with some distortion. These viruses may be transferred back to tobacco, are carried in certain weeds, and are considered to be a factor in the potato degeneration problem.

What appears to be true tobacco ringspot has been transferred to tobacco from naturally infected Irish Cobbler potatoes having a yellow and green mottled disease similar in symptoms to those described for *Aucuba* mosaic. It is a distinct disease from the so-called "ringspot" transferred from "healthy potatoes," the latter appearing to be the "healthy potato" virus disease. Evidence has been obtained of seed transmission of the virus which causes ringspot of tobacco. Several seedlings of a lot of plants raised in the greenhouse from seed obtained from a ringspot inoculated plant, developed peculiar symptoms which consisted of chlorosis of the borders of the leaf toward the distal end, and sometimes resulted in a pinched appearance near the tip of the leaf. Transfers from these plants to healthy tobacco produced typical ringspot.

Bacterial Leaf-Spot Diseases of Tobacco. Work was continued in an attempt to control angular leaf-spot and wildfire in the plant bed thru the use of sanitary precautions. Using greenhouse raised seed, new cotton, and cotton which had been stored away from all tobacco trash, and exercising care to prevent the introduction of tobacco trash from any source, abundant angular leaf-spot and a small amount of wildfire infection resulted following a heavy rain which flooded the beds. The evidence again indicates that local vegetation harbors the two diseases, and that it is washed from this to the beds during heavy rains. Isolations from spots on elder leaves (*Sambucus* sp.) yielded bacteria that produced typical angular leaf-spot on tobacco, but the results need further confirmation before they can be accepted.

Black Root-Rot of Tobacco in Plant Beds. In 1928, it was

found that black root-rot of tobacco was prevalent in plant beds in Daviess County due to the continued use of the same plant bed site and insufficient steaming. In 1929, black root-rot-resistant strains of dark tobacco were tested in diseased plant beds in comparison with local varieties. In nearly all tests the resistant tobacco outgrew the local type in the bed. When set in the field, the resistant sometimes outgrew the susceptible strains, especially where manure had been used, but in most cases growth was about equal, indicating that the acid soils of this section have not become seriously contaminated thru the use of diseased plants. The results of the plant bed tests in Daviess County and at Lexington indicate that strains of both dark and burley tobacco may be developed which have sufficient resistance to grow normally in diseased plant beds.

Soil Fields. Crop yields for 1929 on the soil experiment fields have shown the great value of good soil management, as indicated in the following table:

	Berea	Fariston	Campbells- ville	Hopkins- ville	Green- ville	Mayfield	Average
CORN, bushels per acre							
No treatment	1.9	9.0	14.7	.....	15.5	47.1	17.6
Manure	10.2	17.1	31.9	41.5	28.9	67.0	32.8
Manure, limestone, super-phosphate	58.0	61.9	71.0	60.0	47.2	77.9	62.7
SOYBEAN HAY, lbs. per acre							
No treatment	780	900			1660	2850	1548
Manure	2070	1633			2845	3585	2533
Manure, limestone, super-phosphate	4270	5140			4870	4580	4715
WHEAT, bushels per acre							
No treatment		failed	3	.....	3.2	1.5	.....
Manure		1.3	1.9	3.1	4.2	6.3	3.2
Manure, limestone, super-phosphate		16.2	3.3	6.3	17.0	16.3	11.8
CLOVER HAY, lbs. per acre							
No treatment	1120	100	710	.....	960	550	688
Manure	1640	480	1690	2050	1570	1833	1544
Manure, limestone, super-phosphate	3790	3260	5070	5300	4690	5300	4568

On these fields, manure was used on corn in 1929 on the fertilized and unfertilized land at the rate of 1 ton of manure for each ton of crop harvested from the rotation of the preceding year, except at Hopkinsville where no manure was used this year. The land was manured three years ago when in corn. Thus, the fertilized land received considerably more manure than the unfertilized land. The other crops received the residual effect of manure applied in previous years.

In the tobacco rotations, the following yields were obtained:

	Campbells- ville*	Green- ville	Hopkins- ville	Mayfield†	Average
TOBACCO, lbs. per acre					
No fertilizer	452	415	788	880	634
Limestone, superphosphate ..	863	1090	1150	1264	1092
Limestone, complete fertilizer	1190	1172	1220‡	1456	1260
WHEAT, bus. per acre					
No fertilizer	7.9	‡	5.3	7.7	7.0
Limestone, superphosphate ..	20.8	‡	10.3	21.1	17.4
Limestone, complete fertilizer	19.8	‡	12.3‡	29.3	20.5
CLOVER HAY, lbs. per acre					
No fertilizer	1240	950	1467	712	1092
Limestone, superphosphate ..	3780	5040	2200	4080	3775
Limestone, complete fertilizer	5220	4470	.....	5120	4937

*Land at Campbellsville and Mayfield received uniform applications of manure at rate of 5 tons per acre.

†Limestone, superphosphate and potash.

‡Wheat in alternate years here.

A test of a number of rotations was begun in 1920 on the Station farm at Lexington to determine their effect on productivity. No manure or fertilizers are used in these rotations. The land was uniformly limed in 1927. All crops are removed except the first year growth of clover and the second crop of second year clover. Winter cover crops of wheat are used after

corn and beans. The average yields of corn and wheat in these tests by rotation periods, are as follows:

ROTATIONS

	1921-23 Bushels	1924-26 Bushels	1927-29 Bushels
CORN			
Corn-wheat-clover	50.4	66.5	59.9
Corn-wheat-orchard grass	44.9	63.1	55.0
Corn-wheat-soybeans	53.1	66.9	44.9
Corn-soybeans-wheat	45.9	52.2	37.1
Corn-wheat-clover	47.5	59.7	62.2
(Duplicate of No. 1)			
WHEAT			
Corn-wheat-clover	20.4	22.1	22.9*
Corn-wheat-orchard grass	21.0	18.9	19.5
Corn-wheat-soybeans	19.6	19.7	19.3
Corn-soybeans-wheat	19.6	14.1	24.3
Corn-wheat-clover	22.1	23.6	22.8

*Average of 1927 and 1929; wheat a failure in 1928.

Hill Application of Fertilizer. On the Campbellsville soil field, tests were carried out in duplicate, one set being on unlimed land and the other on limed land. The land had been under regular rotation cropping for 10 years, with broadcast applications of 600 pounds of superphosphate and 150 pounds of muriate of potash per acre per 3-year rotation. Nitrate of soda was used around the hill in both broadcast and hill tests at the rate of 100 pounds per acre. No advantage was found in this case in hill application. In tests on the Experiment Station farm at Lexington, on land that has had no manure or fertilizers in many years, it was found that application of 125 to 250 pounds of 4-10-6 fertilizer per acre were much more effective all in the hill than all broadcast.

Corn. A preliminary test was made of the yielding capacity of first generation hybrid seed corn produced by crossing strains of corn self-pollinated on the Kentucky Experiment Station farm for a number of years. Plots of the hybrid seed resulting from each cross were planted in comparison with the

parent varieties and other standard sorts. The results indicate that at least two of these crosses produce seed of exceptional yielding capacity. One hybrid yielded ten bushels more per acre than the highest yielding open pollinated sort, and the other seven bushels more. Also, the quality of the corn was decidedly superior. The results seem to prove conclusively that hybrids from self-pollinated strains can be produced that will greatly outyield the standard open pollinated varieties. Numerous crosses will be tested in an effort to find the best possible combinations of inbred strains among those at the Station, and eventually it is hoped to distribute these among seed growers in the state.

Sweet Clover Clipping Studies. Frequent cutting sufficient to maintain a reduced top growth somewhat similar to that from pasturing did not significantly affect the stand, although it resulted in plants with small root systems. Cutting for hay at any time during the summer has again been found to result in restricted development of the roots and sometimes in reduced stands. The cutting of August 27, 1929, was the most harmful one of the season, agreeing approximately with results of clippings made in former seasons. Late September cutting had little or no harmful effect. The time of cutting in relation to the stage of root development is apparently very important in determining not only the future development of the roots, but also the stand remaining at the end of the summer.

Microchemical tests indicate that the relative food contents in roots is similar, irrespective of the time at which their tops are removed. Possibly the plot that was kept cut short through the summer showed slightly the least, and there was a suggestion that the roots of plants from which the tops had not been cut were very slightly richer than were the roots of plants from which the tops had been removed in late September. It appears, therefore, that the important effect from cutting for hay is the restriction of the development of the root system.

Red Clover Studies. The study of red clovers of different origin, conducted in cooperation with the United States Depart-

ment of Agriculture, gave results in 1929 similar to those obtained previously. Adapted Kentucky strains in the 1928-29 crop outyielded the native northern lots by a ratio of two to one, and the lots from western states by a still wider ratio. Foreign lots, on the whole, failed completely, altho French clover gave a good hay crop in a test in the western part of the state.

Many new Kentucky-grown lots of promising histories were sown in the test of 1929-30. The southern anthracnose (*Colletotrichum trifolii* B & E) for the second time, in the year of seedling, practically destroyed a few domestic lots, and damaged the foreign lots, which included those of Italian, Russian and French origin. Several Kentucky-grown lots were but slightly injured by the disease; a few, however, were severely damaged, indicating that they are not adapted to conditions within the state. A root disease, apparently the same as previously described from this Station, caused considerable damage during the past summer. Clovers previously determined adapted to Kentucky apparently were less injured than other lots.

Sterility in Mares. Of the total number of foals examined, *Bacterium viscosum* equi was isolated from over 50 percent. Progress has been made in the study of this microorganism. Cultures obtained from different animals and, in some instances, from the same animal, showed marked cultural and serological differences. Considerable detailed work of a technical nature has been done in the classification and typing of different strains of the bacillus. For several years, an effort has been made to obtain evidence as to the habitat of *Bacterium viscosum* equi outside its occurrence in foals.

Recently it has been obtained from the crypts of the tonsillar region of two thoroughbred mares aged 22 and 14 years, respectively, and an aged mule. It has also been isolated from the tonsillar crypts and taste buds of a 7-months old foal and a 17-day old foal. The two foals were affected with a generalized streptococcic infection.

Bacterium viscosum equi was not found in any of these animals except in the mouth. On the basis of these five cases, it

seems that this microorganism is normally present in the oral cavity of the horse. It is known that adult horses are almost wholly resistant to the action of this microorganism even when injected subcutaneously with rather large doses. The isolation of this organism from infected crypts of the tonsillar region of these mares suggests the possibility that adult horses actually serve as infection carriers or as reservoirs for this particular infection.

Parasites in Young Foals. This problem is as important as that of infections, particularly as a post natal problem. Of twenty yearling foals presented for post-mortem since July 1, 1929, all were found to be badly infested with nematode parasites. One of these parasites, *Strongylus vulgaris*, regularly invades the circulatory system with a predilection to lodging in the anterior and posterior mesenteric arteries and their numerous branches. The artery in which the parasite becomes lodged undergoes dilatation, the intima of the vessel is destroyed, followed by severe inflammation and exudation. As a result, the distended blood vessel becomes filled with parasites, coagulated blood and tissue detritus, often completely occluding the lumen of the vessel and thus interfering materially with the circulation of the blood thru the area. The inflammatory process extends thru the wall of the vessel into the surrounding structures, producing thickened fibrous areas of inflammatory tissue. These so-called verminous aneurysms of the mesenteric artery and the inflammatory tissues surrounding them make in the aggregate large masses of diseased tissue often from four to six inches in diameter. Suppurative processes within the accumulated exudate in the diseased blood vessels and in the adjacent lymph glands often contain the microorganism *Bacterium viscosum* equi. In some cases this microorganism may be isolated from this area and not found in other parts of the body. At other times the infection becomes general or septicemic in character. There are two possible explanations for the presence of this infection in the verminous aneurysms. First, it is well known that microorganisms which have gained entrance to the blood stream

have a tendency to localize in any weakened or diseased area in the body. The other explanation is that the larval form of *Strongylus vulgaris* in its migration from the intestines to the mesenteric arteries carries *Bacterium viscosum* equi with it. Young foals two to three months of age, often show well-developed verminous aneurysms upon autopsy. In one foal three weeks of age, the beginning of a verminous aneurysm in the mesenteric arteries was visible and larvae of *Strongylus vulgaris* were present.

The dam usually is an active spreader of parasite eggs and stables and pastures are heavily infested. If young foals are to be effectively protected from the ravages of this and other parasites it must be done by preventive measures. It is possible and practical to raise colts free of parasites. The procedure is comparatively easy of execution and would save the horse breeding industry many thousands of dollars. Horses free of parasites may be maintained on less feed and kept in better flesh and health than those on full feed that are infested with parasites. Young horses free of parasites grow more rapidly, are stronger, more vigorous and far less susceptible to serious attacks of many of the infectious fevers common to young horses.

Infectious Abortion in Cows, Mares, and Sows. During the year, 1437 cows in 85 herds were tested for abortion and melitensis infection. Bacterins made from the *Bacterium abortus* (Bang) were mailed to the veterinarians of the state for inoculating against abortion, the amount being for 1052 cows in 50 herds. One human blood sample was tested with negative results.

Placentas and fetuses from ten cows were cultured for abortion. *Bacterium abortus* (Bang) was isolated from two, and a streptococcus from one. Forty-four mares were tested for infectious abortion and 2571 mares, on 76 farms, received the bacterin treatment. One abortion occurred among these mares due to the *Bacillus abortivo-equinus*. This mare aborted 22 days after she received the third treatment and may have picked up the infection before she was vaccinated. Eighteen fetuses from mares were cultured during the year. *Bacillus abortivo-equinus*

was isolated from one, a streptococcus from three, and the others were found to be negative to either of these organisms. Nineteen samples of blood from sheep were tested for abortion with negative results. Seven samples of blood from sows were tested for abortion and 202 sows in three herds received treatment of a bacterin made from *Bacterium abortus suis*.

A culture of *Bacterium abortus* (Bang) was isolated April 18, 1929, from the afterbirth of a cow that gave premature birth to a weak calf. This cow was in a herd where infectious abortion existed. The calf, tho weak, was still living at the last report received which was May 15. Only three small colonies of *Bacterium abortus* (Bang) developed on the plate cultures made from the afterbirth of this cow. Subcultures were made from these and they were labeled No. 1S, No. 2S, and No. 3S. The fourth generation of No. 2S and No. 3S grew aerobically, but No. 1S did not grow aerobically until the fifth generation. In isolating the *Bacterium abortus* from aborting sows (1916) it was found that the first generations grew aerobically, differentiating the strains isolated from cows, which required several generations of growth in a partial oxygen pressure before they developed aerobically.

A test was made to determine whether or not the passage thru a sow of a strain of the organism recently isolated from a cow and before it would grow aerobically, would enable it to grow aerobically. Also, to determine whether the passage of the bovine strain of the organism thru a sow would change the physiological characters of the organism other than that of degree of oxygen requirement.

A pregnant sow was injected intravenously on May 14 with a saline suspension (10 c. c.) of organisms washed from two agar slants of the first subcultures of No. 1S and No. 3S. On May 31, the sow aborted nine pigs, two of which were alive. One of these live pigs showed some strength, kicking its legs but not attempting to stand. The other was not so vigorous. These were killed and cultures were made of the internal organs of these two and also of the other seven pigs. The organism was

recovered from four of them. There were two types of colonies, smooth, shiny, dewdrop colonies, and rough, flat colonies. The second generation of one of the rough colonies grew aerobically, but the clean, shiny colonies did not grow aerobically until after the fourth generation. After the fourth generation the stock cultures which were transplanted about every 30 or 45 days would not always grow unless cultured under anaerobic conditions. The passage of the bovine organism thru the sow did not seem to change its adaptability to grow only under partial anerobic conditions for the first few generations. Agglutinins for the swine strains of *Bacterium abortus* (Bang) developed in the serum of the sow over those of the bovine origin. Peculiarly no agglutinins developed in the sow for the bovine strain injected. However, serum from an aborting cow agglutinated an antigen made from this strain in a dilution of 1 to 500.

Plant Poisoning of Livestock. Several cases of suspected poisoning were investigated. Losses in one flock of sheep were definitely determined to be due to poisoning by *Cicuta maculata* (water hemlock). Losses in another flock ceased as soon as the sheep were removed from a pasture that contained many plants of *Datura stramonium* (jimson weed). An inspection of the pasture showed that these weeds had been grazed by the sheep. Jimson weed has long been known to be poisonous, but it is seldom consumed by livestock. Water hemlock is not common in Kentucky and usually causes no trouble except in the early spring.

Acidosis of Pregnant Ewes. The results of a study of this disease extending over a period of years indicate that the problem is fundamentally one of nutrition. It has been found from examination of the blood that ewes suffering with acidosis show a calcium content of the blood below that of ewes that were being fed a well balanced ration and in which no cases of acidosis occurred. In two lots of experimental ewes carried thru the breeding season no cases of acidosis occurred. The five ewes in lot 1 received a ration of grain and roughage relatively high in calcium, while the five in lot 2 received a ration of grain and

roughage relatively low in calcium. At the beginning of the experiment the average calcium content for all ten ewes was 9.9 mg. per 100 cc. of serum. At the end of six months, it was found that the average calcium content for lot 1 was 9.8 mg. per 100 cc. of serum, while for lot 2 it was 8 mg. per 100 cc. of serum. In one ewe the calcium content was found to be as low as 6.7 mg. per 100 cc. of serum. This is a difference in calcium content of 1.8 mg. per 100 cc. of blood for the average of both lots

There seems to be a decided difference in the ability of individual animals to maintain the calcium content of the blood when kept under the same conditions and fed the same kind of feed. So far no explanation has been found for this great variation. It has been observed in the field and it has been stated by many men experienced in the sheep business that acidosis usually makes its appearance following sudden changes in the weather, especially exposure to cold; going without water, following salting and from having gone without salt. This indicates that in pregnant ewes the calcium content often reaches a minimum that represents the border line between health and disease. When this low point has been reached the predisposition to acidosis is apparently great and any irregularity in feeding, care and management, especially exposure, may result in the development of the disease.

Bang Abortion Test. From April 15 to December 31, 1929, more than three thousand samples of blood have been tested for Bang abortion infection by the agglutination method. From 300 to 400 of these were retests. The first test of these animals showed only 25 percent to be reactors. In test work previous to April 15, 1929, the number of blood samples showing positive reaction was considerably larger, but the percentage of reactors was smaller during the last eight months. This does not necessarily mean that the infection is on the decline. Previous to April, 1929, most of the test work was of mature animals in raised for dairy cows and of herds where no serious trouble. Much of the work since April has been on young animals for

shipment either out of or into the state, of young heifers being raised for dairy cows and of herds where no serious trouble from abortion infection had recently occurred. In most of the well established herds where testing has been done the owners are planning to eliminate infected individuals and attempt to build up a Bang abortion disease-free herd.

Coccidiosis. Laboratory examinations of 1541 specimens from diseased animals have been made. Coccidiosis has been recognized in five different species of animals, namely, cattle, sheep, swine, chickens and dogs. All animals from which material was obtained for examination were suffering with an intestinal disturbance and showed, on post-mortem, inflammation and hemorrhage of the mucous membrane over limited or extensive areas thruout the digestive tract. In all cases where coccidia were demonstrated to be present they were, so far as could be determined, the primary cause of the trouble. It has been known for some time that coccidiosis in chickens is a common and serious disease and that intestinal coccidiosis of cattle is encountered frequently. However, finding coccidiosis in sheep and pigs, in 1929, is the first time that the disease has been positively diagnosed in these two species of animals in Kentucky. The inflammatory changes in the intestines of pigs where coccidia were found were different from those previously observed in cases of enteritis and colitis in swine.

Fowl Paralysis. This disease is becoming increasingly prevalent in the state. Previous to 1929, it was relatively rare. The affected birds first show incoordination which progresses to partial paralysis. Complete paralysis has not been observed. Both the wings and the legs may be affected. Frequently the neck also is involved. The disease occurs in birds ranging from five to twelve months of age. During the first part of the season, 80 to 90 percent of the cases showed an infestation of coccidiosis while, later, tapeworms were found in at least 75 percent of the cases. All the cases of fowl paralysis that have been examined showed chronic enteritis. Under-development of the ovary and

testes was also frequently observed. Lesions in the nervous system, both gross and microscopic, were observed in a few cases.

The cause of fowl paralysis has not been determined. To date, it has not been possible to transmit the disease experimentally. Subcutaneous, intramuscular, intravenous, and intraperitoneal injections of blood, emulsions of brain, spinal cord, liver and spleen have been tried. Also, the organs of diseased birds have been fed to susceptible birds with negative results. Six healthy cockerels, three months of age, obtained from a hatchery, remained well after being in the pen with sick birds for four months.

Paratyphoid Infection of Chicks. Serological studies of bacilli of the paratyphoid B group isolated from an outbreak of an acute disease in chicks showed that two microorganisms were present. One of these, *Bacterium aertrycke*, has been previously found in chickens. The second, *Bacterium anatum*, has only been isolated once before and has not previously been found in chickens.

Effects of Vitamin D Supplements for Chickens. The second year of the experiment comparing Kentucky sunshine with irradiation from quartz mercury vapor lamp and cod liver oil as sources of vitamin D for chickens has been completed. Some of the findings to date are (1) the absence of a vitamin D supplement in the ration of both pullets and yearling hens resulted in a material reduction in egg production and a progressive decrease in hatchability; (2) direct sunlight received by both hens and pullets running on bluegrass range was more effective in increasing egg production than either irradiation or cod liver oil; (3) sunshine was the most effective factor in increasing the hatchability of eggs from both hens and pullets; (4) vitamin D from either cod liver oil or irradiation by a quartz mercury arc lamp was effective in increasing the hatchability of eggs from hens and pullets.

Supplementing a Meat Scrap Mash with Dried Buttermilk. A feeding trial was conducted with White Leghorn yearling hens to determine the value of supplementing a portion of the

protein in the standard laying mash (containing 20% meat scrap) with a commercially available source of milk. Steamed bone meal was added to the ration of pen 4 to equalize the phosphoric acid content with that of pen 1, which received all its minerals from meat scrap. The winter and yearly production together with the 1929 hatch are given in the following table:

Pen No.	Protein Supplement	1929 Hatch	Egg Production	
			Winter	Year
1	20% meat scrap	53.8%	55.9	154.9
2	10% meat scrap—10% dried buttermilk	50.2%	38.4	160.4
3	10% meat scrap—5% dried buttermilk....	62.9%	29.2	132.1
4	10% meat scrap—5% dried buttermilk, steamed bone meal	52.4%	32.3	129.6

These data are insufficient for drawing definite conclusions, but indicate that the standard 20 percent meat scrap mash which has been recommended by the Kentucky Experiment Station for the past twelve years is quite effective in producing large winter and yearly egg yields from yearling hens as well as satisfactory hatches.

Selective Poultry Flock Improvement. The third year of the long-time breeding project with White Leghorns has been completed. Each year the breeding flock of 100 to 125 hens (yearlings and older) is made up of late-molting hens that showed external characters indicating large egg production. These selected hens (no trap-nest records available) are mated in one large flock to pedigreed cockerels from the line-bred strain of the Experiment Station, out of hens with records between 240 and 260 eggs. The original flock (1926 hatch) during the laying year 1926-27, average 158 eggs each as pullets. The following year (1927-28) the average for the 1927-hatched pullets was 185 eggs each. The pullets hatched in 1928 just completed 11 months lay with a record of 189 eggs each. Owners of farm flocks might expect similar increases in production if pedigreed males from known high producing hens are used each year and mated to flocks of selected hens.

Metabolism in the Chicken. In studying the distribution of blood calcium in the circulation of hens, blood was obtained from the anterior mesenteric vein, the anterior mesenteric artery and the left ventricle of laying and non-laying White Leghorn hens that had been anesthetized with chloral hydrate. The results indicate that in non-laying hens, the arterial and venous blood contained the same amount of calcium, which shows a state of calcium equilibrium. In actively laying hens, the calcium content of blood from the anterior mesenteric vein was appreciably larger than that of blood from the anterior mesenteric artery, and blood from the left ventricle was intermediate between these values. In other words, the arterial blood going to the intestines containing calcium carbonate takes up calcium and passes thru the veins to the heart where it is apparently diluted with blood containing a smaller percentage of calcium.

Results of an investigation now in progress concerning the transference of the proteins in egg-white from the cells of the oviduct of the hen indicate that the egg shell membranes are impermeable to most of these proteins, if not all. From this it seems that the egg-white proteins are placed around the yolk in the oviduct before the membranes and shells are formed.

In studying the formation of eggs in a hen, it has been shown that when calcium carbonate is removed from a grain-skimmilk-calcium carbonate ration, there follows a continued decrease in the number of eggs produced. Eventually, the eggs laid will be comparatively smaller and have thinner shells and lower hatchability. Investigations are in progress to determine the cause of the small percentage hatchability of fertilized eggs in the absence of the calcium carbonate supplement. Blood has been obtained from the large wing veins of laying hens that were receiving a ration consisting of ground yellow corn-wheat-middlings-skimmilk and calcium carbonate. The calcium carbonate supplement was removed from the ration of half of the hens and at later dates blood was obtained from the wing veins. Calcium was determined in these samples of blood. Results show that those hens which received the calcium carbonate thruout the experiment progressively increased the average number of eggs

laid, the average weight of the eggs laid, the average weight of the shells and the percentage of calcium in the blood, while those hens that received the ration from which the calcium carbonate supplement had been removed, showed a decrease in the number of eggs laid, smaller average weights of the eggs and egg shells and the percentage of calcium in the blood was smaller.

Anti-Rachitic Value of Egg Yolks. A comparison has been made of the anti-rachitic value of the yolk of eggs produced in the spring and stored until fall and winter, with that of yolks from eggs produced in the fall and winter. The conditions of production were the same with the exception of the season of the year. The anti-rachitic value was tested on white rats, using as criteria x-ray pictures of the hind legs, analyses for the inorganic phosphorus content of the blood and percentages of ash and of calcium in the bone. The results indicate that the anti-rachitic value of eggs produced in the spring and stored until fall and winter is greater than that of eggs produced in the fall and winter under like conditions.

Hog Feeding. In a previous experiment in feeding hogs it was noted that hogs fed ear corn in the mud consumed a larger amount of a mineral mixture (self fed) than did hogs receiving ear corn from a self feeder or hogs fed ear corn on a platform. A feeding test similar in plan was conducted during the year, except that an additional lot of hogs was fed ear corn on the hard ground. The hogs in all the lots were also allowed a mixture containing digester tankage 50 parts, linseed oil meal 25 parts and alfalfa meal 25 parts. In addition, all the hogs had free access to a mineral mixture consisting of steamed bone meal 40 parts, finely ground limestone 40 parts and salt 20 parts. The experiment lasted 60 days. During this time the hogs fed ear corn from a self feeder ate .65 pound of the mineral mixture per hog; those fed on a platform ate .45 pound; those fed on hard ground ate .15 pound; and those fed in the mud ate 1.7 pound. The rate of gain per hog in the different lots was nearly the same. The results were quite similar to those obtained in the previous trial.

Steer Feeding. A third experiment was conducted from December 21, 1928, to July 20, 1929, inclusive, a period of 212 days, to compare the daily rate of gain and economy of gain between steers fed corn during the winter and finished on grass the following summer, without corn, and steers carried thru the winter on the same feeds, except corn, and finished on grass the following summer with corn. During the winter feeding period, which extended from December 21, 1928, to May 11, 1929, the kinds and amounts of roughages for both lots of steers were the same. The roughage consisted of corn silage and oat straw. Both lots received the same amount of cottonseed meal. The average gain of the steers that received corn during the winter was 333 pounds; that of those fed corn on grass was 338 pounds. The net return over the feed consumed and shipping expenses was \$3.21 per steer for those receiving corn during the winter, and \$3.03 per steer for those fed corn on grass. The initial cost of the cattle was \$12 per hundredweight. Both lots were sold on the Cincinnati market July 20 for \$13.25 per hundredweight. There was practically no difference in the dressing percentage of these two lots and the quality of the carcass was about the same for each lot.

Vitamin B Content of Kale and Mustard Greens. Because kale and mustard greens are much used in Kentucky, in the diet, their content of vitamins A, B (F and G), C and D has been studied. The investigation of the vitamin B content of kale was undertaken before methods had been determined for a separate study of the fractions of what was then termed vitamin B. The later work, however, was done on the two fractions F and G.

The earlier tests showed that one gram of fresh kale contains one rat unit of vitamin B, a rat unit being defined in the terms of Sherman as being the amount necessary to maintain the initial 40-45 grams of weight of an experimental rat kept on a basal diet lacking vitamin B but adequate in all other respects. Altho the experimental animals held their initial weight, they did not show a healthy appearance. They were highly nervous and had poor appetites.

When cooked kale was fed, 83.3 percent of the animals lived up to the eighth week. These died off gradually in the ninth and tenth weeks but they had all gained from 10 to 25 grams.

On three grams of canned kale, weight increases were from 13 to 29 grams in eight weeks. Three out of six animals died in the ninth week and the other two lived until they were killed at the end of the eleventh week. On less than these amounts of either cooked or canned kale, all the animals of each group died before the experiment had run eight weeks.

The tests indicate that one gram of fresh kale does not contain an amount of the anti-neuritic vitamin that is protective against beri-beri but does contain a larger amount of the growth-promoting factor. The results of the tests on cooked and canned kale indicate the same thing. Since on 3.5 grams of cooked kale, and 3 grams of canned kale, the animals died even tho they had gained weight, the inference seems to be that the cooking had decreased the anti-neuritic factor, but not the growth-promoting vitamin, the decrease of the anti-neuritic factor of the canned kale being less than that of the cooked.

Tests were made of the relative amounts of anti-neuritic and growth-promoting vitamin in kale and mustard greens, rather than for vitamin B as a whole. Graduated amounts of fresh, cooked and canned kale were added to .4 gram autoclaved yeast to test for the anti-neuritic factor and to .4 gram wheat to test for the growth-promoting factor. The same procedure was followed for mustard greens.

The results indicate that 2 grams of fresh kale per day are necessary to protect from beri-beri when .4 gram autoclaved yeast is added to supply the growth-promoting vitamin. When, however, the anti-neuritic vitamin is supplied by .4 gram wheat, the animals maintained weight for eight weeks on 0.75 grams of fresh kale.

Fresh mustard greens show a slightly higher content of the anti-neuritic vitamin than kale, 1.5 gram giving what seemed to be the same degree of protection against beri-beri as 2 grams of kale.

The test for the growth-promoting factor shows results much like those for kale; that is, 0.75 gram per day plus .4 gram wheat served to keep the animals at about the initial weight for eight weeks.

Supplying the growth-promoting vitamin by autoclaved yeast required 3.5 grams to protect against beri-beri and 3 grams of canned kale. The results on mustard greens are not quite so conclusive because the animals did not always eat all of the larger amounts. The averaged figures, however, seem to indicate that 3 grams of cooked mustard greens and 2.75 grams of canned mustard greens are sufficient to protect against beri-beri. The growth-promoting factor was shown as being sufficient in 3 grams of both cooked and canned mustard greens to maintain weight for eight weeks.

Therefore, in comparing vitamin B content of kale and mustard greens with that given for other articles of food, it may be concluded that these greens compare favorably with green string beans, apples, carrots, lettuce, potatoes and tomatoes, but that they are lower in vitamin B content than navy beans, eggs, peas, prunes, spinach and whole grain cereals.

Cooking Quality of Potatoes. Investigations have been made on the cooking qualities of potatoes to find standards by which more intelligent purchase of them may be made by housewives. Five different lots of potatoes were studied, all of the same strain, but grown under different soil conditions. They were tested by baking, boiling and steaming. The qualities upon which judgment was passed were mealiness, whiteness and flavor. In addition, analyses were made for total solids, ash titratable acidity, total nitrogen and sugar, to find upon what the cooking qualities depend.

Much difficulty was experienced in defining a standard for the cooking tests. Mealiness was determined by appearance, breaking with a fork, and feel on the tongue. All the testing had to be subjective and the personnel of the judging committee changed to some extent. Therefore, it is not possible to draw definite conclusions on the data thus far obtained. The

results indicate, however, that lot V, grown in soil that had had a sod cover crop and manure, were most often given first place in mealiness, whiteness and flavor; and that lot I, described as grown on bottom land, highly manured and fertilized, and lot III, described as grown on manured land, were placed last most often, lot III a little more often than lot I.

Lot V showed the highest value in total solids, and lot III the lowest. In ash value, lot III showed the highest figure. In sugar analysis, lot III ran markedly low, while lot V was not so high as either lots II or IV. No striking differences appeared in the other factors for which analyses were made.

Some correlation may be seen between cooking qualities and sugar content, but until a better standard is found for judging mealiness, whiteness and flavor, it would be inadvisable to attempt to show further correlations.

Potato Flea Beetles. The study of the life histories and habits of *Epitrix fuscata* and *Epitrix cucumeris*, two flea beetles that injure potatoes in Kentucky, was completed this year. The life histories of the two beetles are practically identical. Both species begin collecting on the young plants about May 1 and may be found on the plants until cold weather. The period of development from egg to the adult stage is about 35 days for both species and there are two broods a year. The beetles eat small holes in the leaves which weakens the plants and the larvae bore into the tubers, with the result that the surface of the tubers become roughened and pimply. *Epitrix fuscata* is much more numerous than *Epitrix cucumeris* and accordingly does more damage to the plants.

Potato Leafhopper. The study of the leafhopper was continued thru the season of 1929. Different strains of clover and alfalfa were grown in the field under two sets of insect-proof cages so that for each infested row of clover or alfalfa there was a check or uninfested row. Reduction in yield of air-dried plants was noted for each infested row when compared with its check row. The yields of dry weights of the infested plants as compared with the uninfested plants are as follows: Kentucky

red clover, 4.4 percent; Italian red clover, 61.2 percent; French red clover, 32.5 percent; Michigan red clover, 6.8 percent; Idaho red clover, 44.4 percent; Oregon red clover, 35.7 percent; Minnesota red clover, 12.9 percent; Ontario variegated alfalfa, 67.3 percent; Kansas common alfalfa, 68.6 percent; North Dakota alfalfa, 66.6 percent. The leafhopper prefers the smooth-stemmed strains of clover to the relatively more hairy strains as hosts. Many more nymphs in both field and laboratory trials developed on the foreign clovers than on the native clovers.

Vegetables. A variety test of cabbage, tomatoes and peppers indicated that the Long Island strain of Golden Acre cabbage, the Penn State Earliana tomato, and the World Beater pepper, were outstanding for production and early maturity.

The study on the effect of artificially maintained soil reaction on nitrification and on yield and composition of forced tomatoes and lettuce has made good progress. The data are not complete, but the results to date show that (1) the largest yields of both tomatoes and lettuce have been secured in the pH range 7.5 to 8.5. The use of sodium carbonate to build up alkalinity has caused a marked increase in yield over all other treatments and checks. (2) An increase in yield occurred on the acid side compared with checks in the pH range 5.5 to 6.5, but did not equal the increases found on the alkaline side. (3) Nitrate and total nitrogen have been low on the acid range and high on the alkaline. On the alkaline side, the lime-treated soil contained comparatively small amounts of soluble manganese and phosphorus, and a larger amount of nitrate than the checks, while the sodium carbonate treatment resulted in slightly larger amounts of active manganese and phosphorus than the checks and a much larger nitrogen content. Evidence has been obtained to indicate that soluble manganese was present in sufficient amounts to be toxic in the acid plots ranging above 5.5 pH. The high yield of the plots treated with sodium carbonate may be explained in part by the abundance of nitrogen and soluble phosphorus and the moderate amount of soluble manganese present in these soils. The only plausible explanation for the large nitrogen content of the plots treated with lime and sodium car-

bonate is that the activity of nonsymbiotic nitrogen fixing bacteria was stimulated by the alkaline reaction.

Mulch Paper on Vegetables. The use of paper mulch on cabbage, beets, carrots, string beans, tomatoes and peppers resulted in no significant differences in total yield. There was a marked stimulation of early yields on mulched beans and tomatoes planted April 16 and 20, respectively, but later plantings showed little advantage and the yield was decreased in some cases. The yield of cucumbers, squash and muskmelons was increased, due to the earlier maturity of the fruit before pests and drought killed the vines. Work with paper mulch on cucurbits should be continued. Considerable difficulty was experienced in laying the paper to prevent wind damage.

Berries. A good crop of dew berries was produced in the second season after planting. The Young variety was particularly noteworthy. The berries of this variety were much larger and better in quality than the Lucretia, now commonly grown. The berries are too soft for shipping, but are most promising for the home garden and local market.

In the variety test of raspberries, the Latham gave the largest yield among the red sorts, yielding at the rate of 180 24-pint crates per acre. The size of berries measured almost twice that of Cuthbert, or an average of 225 berries to the quart, as compared with 400 berries to the quart for Cuthbert.

The Plum Farmer and Quillen varieties of black raspberries produced a larger crop than the other varieties tested. Evidence was obtained which indicates that black raspberries should not be planted near red varieties, because of the spread of mosaic diseases. The red varieties appear to be infected generally with a type of mosaic which seems to cause little injury to them, but spreads readily to the black raspberries, causing severe injury.

A plot of Premier strawberries, measuring one-seventh acre, planted in the spring of 1927, was fruited again in 1929. A part of this plot was reconditioned, after the first crop was removed, by narrowing the rows with a plow and cultivating thruout the summer, while the other part was left undisturbed except that

the weeds were cut out with a hoe. The yield from the cultivated part of the plot was 22 percent greater than that of the uncultivated part. The total yield from this plot in 1928 and 1929 was 90 24-quart crates.

The study of the effect of varying degrees of hydrogen-ion concentration on the growth of strawberries in sand culture has been completed. The results show that plants grow best at a reaction of about pH 5.30 to pH 5.50. Reactions of pH 3.00 and 9.00 were prohibitive to growth, but extreme acidity was more quickly toxic than extreme alkalinity. A reaction that was most favorable for growth also induced greatest fruitfulness.

Peaches. The Elberta peach block of .7 acre produced 192 bushels in 1929. This block of peaches provided an opportunity to continue experiments on thinning for the purpose of determining if the period over which effective thinning may be done, can be extended later in the season than is commonly practiced. The later effective thinning can be done, the easier it is to detect and eliminate defective fruits. Fifty-six trees were used for this experiment. Thinning was done May 10, June 4, June 19 and July 5, and comparisons were made with unthinned checks. Thinning done June 4, or 57 days after petal fall, gave the greatest increase in size. Thinning on July 5 gave little increase over no thinning.

The young variety peach orchard, 3 years old, produced its first crop. Of the varieties included in this block only one, the Golden Jubilee, was outstanding. The fruit of this variety was large, attractive and of good quality. It appears most promising as a yellow-fleshed peach ripening at the season, July 15-20.

The Oriental peach moth did considerable damage to peach twigs during the summer. About 3 percent of the Elberta fruit was infested with worms. All varieties ripening after Elberta were so wormy that they were unmarketable.

Plums. The Wild Goose plum has proved the hardiest and most reliable variety of plums grown at the Station and the most satisfactory of the American varieties. The Archduke has been the best late purple variety of European plums. The

Kahinta, a Japanese cross American hybrid, is one of the most promising of the newer sorts. The tree is productive and the fruit is large, attractive and of good quality. The Gonzales, a Japanese hybrid, is another variety which appears promising. The tree is productive and the fruit large and attractive, resembling Burbank. The Gonzales and the Kahinta are recommended for trial in Kentucky.

Fireblight in Apples and Pears. The blight cutting work in Johnson County was continued. It was found that while blight was controlled in the early-blooming pears, it was not controlled in apples that bloomed later, during a cool, wet period. While no sources of blight were found in either the pears or apples in this orchard, three pear trees, heavily blighted, were found about a quarter of a mile away. These were thought to be the source of infection for the apples. It appears evident that blight cutting must be extended to neighboring trees in order to be effective in years of severe blight infection.

Control of Greenhouse Pests. Effective control of nematodes in the greenhouse benches was obtained by firing the furnace on hot days in August, with doors and ventilators closed. A temperature of 160 degrees F. was attained in the air, and 140 degrees F. in the soil in the benches. The heating was continued for several days. Previous to heating, the greenhouse benches were thoroly watered.

White fly was controlled more effectively by a pyrethrum spray than by fumigation with nicotine or hydrocyanic gas. The spray was applied with an upturned nozzle to the underside of the leaves. The application was made about noon on a sunny day, with a temperature of 100 degrees F. in the house.

Orchard and Nursery Inspection. Inspection was made of 121 nurseries and 76 certificates were issued on the basis of comparative freedom from insect pests and diseases. In addition, 169 non-resident certificates, 76 agents' permits and 11 dealers' permits were issued. The total number of certificates and permits issued was 332. The major pests and diseases found in the general nursery are San Jose scale, wooly aphis, pear leaf blister mite, oyster shell scale, iris borer, pine bark aphis, poplar

canker, crown gall and willow canker. Among the growers of small fruit plants, the most serious pest is the strawberry crown borer. Of the diseases, anthracnose was the most important. It was found in every block of black raspberries inspected; also to a less extent on red raspberries and blackberries. In all instances where insect pests and diseases were found, remedial measures were given. In some cases, destruction of the plants was necessary; in others fumigation, spraying or dipping was sufficient.

Seed Inspection and Analysis. Samples of seed tested and analyzed number 2,601. Since most of the samples were for both purity and germination tests, the total number of reports issued was about 4,000. These are distributed as follows: Bluegrass, 405; other grasses (redtop, orchard grass, timothy, oat grass, lawn grass mixtures, fescues, canes) 280; clovers (red clover, sweet clover, white clover, crimson clover, alsike clover, lespe-deza) 612; vegetables, 410; tobacco, 536; corn, 87; soybeans, 112; cowpeas, 19; wheat, 18; barley, 9; rye, 54; oats, 31; hemp, 8; millet, 20. In addition, more than 500 pounds of tobacco seed were cleaned.

Creamery License. Licenses totaling 1,155 were issued, authorizing their holders to buy milk or cream on the basis of the butterfat contained therein. These licenses were issued to 40 creameries, milk plants and ice cream manufacturers in operation for one year or more; 4 such plants beginning operation this year; 3 cooperative buying and shipping agencies; 26 independent buyers; 988 cream buying stations in operation June 30, and 94 cream buying stations in operation since June 30.

Thirty examinations for applicants for tester's license were held as follows: Louisville 4, Lexington 6, Bowling Green 5, Paducah 5, Owensboro 5, Cincinnati 2, Maysville 3. Notice of these examinations were sent to 791 persons and 439 applicants appeared. Of those examined 378, or 86 percent, made passing grades. There are now 1,326 authorized testers in Kentucky. Of this number, 993 hold renewal licenses granted July 1, 1929,

238 are new operators licensed since that date, and 95 are operating on permits.

A total of 728 inspections have been made. Based on these inspections the operators were graded as follows: A, B, and C grades, 591; D grade (probation) 124; E (second consecutive D) 13. As a result of these inspections, the licenses of 13 operators were temporarily revoked; 10 were permanently revoked; 2 were continued on probation and 3 are pending action of the Examining Board.

Inspection has been made of 26,570 pieces of glassware, 26 of which were rejected as inaccurate

The receipts for the year were \$11,517.44, and the expenditures \$15,524.22, distributed as follows.

Salaries	\$7,801.96
Labor	262.40
Postage and stationery	228.90
Freight and express	7.73
Sundry and laboratory supplies	154.11
Travel	1,982.21
Furniture and fixtures	66.91
Contingent	5,020.00
Total	\$15,524.22

Feed Control. Chemical standards for many by-product feeds and special-purpose mixed feeds have been adopted. Such feeds must be of reasonable quality before they can be sold under descriptive or special-purpose names. For instance, if wheat middlings contain less than 16% protein and 4% fat and more than 7.50% fiber, they must be labeled with some other name. Another example, a dairy feed has to meet certain requirements before it can be registered and sold as a dairy feed. It must contain at least 16% protein, 3.50% fat and not over 15% fiber to entitle it to registration for sale as dairy feed in Kentucky. If adulterants or fillers are used, their names must be stated in the list of ingredients and the amounts used. A reasonable number of ingredients are required in the mixtures of special-purpose mixed feeds to give palatability and insure the presence

of a variety of protein compounds necessary for the requirements of animals.

The adoption of standards for special-purpose mixed feeds has been of great service to Kentucky feeders. It has reduced the amount of fillers and waste in feeds, raised the quality of feeds and banished from the State many low-quality products. It has been a direct saving to feeders by giving them better feeds at practically the same price, but perhaps the greatest saving has been in the increased results in the production and use of better feeds.

During the year, 1,204 samples of feeds have been analyzed and the results reported to those concerned. Seventeen federal cases for violation of the law have been reported for prosecution. Sixteen state cases for violations have been concluded in the State courts.

Fertilizer Control. Seven hundred and twenty-seven brands of fertilizers were registered, samples from nearly all of which were analyzed. In addition, analyses were made of 799 samples collected by the official inspectors or submitted by individuals. Tare printed for manufacturers numbered 3,232,000. It is estimated that about 93,000 tons of fertilizer were used in the state in 1929.

Public Service Laboratories. Examination has been made of 77,006 samples of food, drug and public health material representing a very wide variety of work, ranging from toxicological examination of human and animal organs, identifications of blood stains as human blood, for use in court, examination of material in bacterial food poisoning cases, microscopical and bacteriological examination of specimens, such as diphtheria, tuberculosis, spinal meningitis, etc., for diagnosis, to the less complex cases of milk, water and similar products. Of the samples examined, 76,172 were handled in the bacteriological laboratory; 660 in the food laboratory, and 174 in the drug laboratory.

The facilities of the laboratories were used by 1,366 physicians, public health nurses, hospitals, city and county health

departments. According to the records for the year, service has been rendered to every county in the state.

ROBINSON SUBSTATION

Forest. Facilities for fire control were increased during the year. The spring fire season was of about average hazard and length. Steady progress has been made in fire control as is indicated in the following table.

Year	No. Fires	Acres	Average Area
1925	26	1115	44.6
1926	35	835	26.0
1927	30	447	19.4
1928	32	182	7.3
1929	32	96	4.6

Two and a quarter miles of new trail were constructed and maintenance work was done on 87 miles. Field work of mapping and estimating the forest was completed in the summer.

In the spring 2,500 trees were planted of the following species: White, Japanese red, Japanese black, Corsican and Austrian pine; Douglas fir, red oak, black walnut, white ash, black locust and yellow wood. A good stand of most of the species was secured and a fair stand of the remainder except Douglas fir. The older plantations made good growth with the exception of Japanese larch. Red, Japanese red, and loblolly pine have done especially well.

Grading Mountain Poultry Flocks. The second year of the grading experiment has been completed and the pullets of the third year have been raised and housed. Ancona males mated to mongrels in 1928 produced grades that exceeded the pure-breeds in both winter and yearly egg production during 1928-29. Doubtless a portion of this increased egg production may be attributed to hybrid vigor as the same males were alternated and mated both to purebred Anconas and mongrels. There was considerable resemblance toward Ancona type and pattern in the grades raised in 1928, while those raised in 1929 (three-

fourths **Ancona**) quite closely resembled purebreds. With the Rhode Island Reds, the grades exceeded the purebreds in winter production, but fell below the purebreds in yearly production. The second generation grades (1929 hatch) appear to be purebred Rhode Island Reds, except for occasional defects and disqualifications.

Confining Hens to Screened Porch. A pen of Barred Rock pullets allowed yard range laid an average of 147.9 eggs in the first 9 months of the year, whereas a pen limited to a small screened wire porch for an outside run averaged 142.1 eggs. This experiment will be repeated to determine if it is practical under conditions where range area is quite limited to confine the laying flock. There was no significant difference between the thickness of eggshell in the two lots, indicating that the pen limited to the screened porch for its outside run secured sufficient sunlight (with its resultant vitamin D) to produce normal shells.

Orchard. The young orchard of apples, peaches and cherries made good growth this year. The prospects for a crop of peaches were excellent in the early spring, but were ruined by frosts. The small fruits and grapes were also damaged by frost and hail. Work on the farm has progressed and on the whole, the crop yields were good.

Meetings. A camp for farm women and homemakers was held July 15 to 19, with thirty women and three instructors in attendance. The 4-H club camp was held in August, and was the most successful of the five such camps which have been conducted at Quicksand. The Fourth Annual Robinson Harvest Festival, September 26-27, was well attended. It showed progress and improvement and the entries were of better quality than in previous years.

WESTERN KENTUCKY SUBSTATION

Pasture Experiments. These experiments are conducted on three 10-acre fields of poor sandstone soil representative of a large area in western Kentucky. One field has received no fertilizer or lime treatment, corresponding, therefore, to large

areas of pasture land in western Kentucky. A second field received 1200 pounds per acre of rock phosphate. The third field received 3000 pounds of ground limestone and 600 pounds of superphosphate per acre. All were sown in the spring of 1928 to a mixture of orchard grass, redtop, Kentucky bluegrass, common lespedeza, white clover and sweet clover. Pasturing was begun in the spring of 1929, using yearling Hereford steers. By October 26, when the final weights for the summer were taken, the untreated field had produced 405 pounds of gain, the rock-phosphate-treated field, 1605 pounds of gain, and the lime and superphosphate-treated field, 1,645 pounds of gain. The plants on the untreated field consisted of several kinds of weeds, redtop, orchard grass and lespedeza; on the rock phosphated field, the vegetation consisted almost wholly of redtop, orchard grass and lespedeza, with the lespedeza furnishing most of the pasturage during the latter part of the summer; on the third field the vegetation consisted almost wholly of sweet clover, orchard grass and redtop, while during the latter part of the season orchard grass and redtop, together with a small amount of lespedeza furnished the grazing.

Fertilizer Tests. In the tobacco fertilizer test the use of 500 pounds per acre of approximately a 3-10-6 fertilizer has increased the yield of tobacco, as an average of 3 years, from 775 pounds per acre (the yield unfertilized) to 1222 pounds per acre. The use of 1000 pounds per acre gave a further increase of 120 pounds per acre. The use of limestone and the same amount of superphosphate as of the complete fertilizer and 10 tons of manure on each crop increased the yield from 777 pounds (unfertilized yield) to 1307 pounds per acre.

An experiment was begun this year, on the sandstone soil of the farm, in which the method of application of fertilizers is being studied. On one plot, the superphosphate and potash fertilizer was applied broadcast; on another, part of it was applied broadcast and part in the hill. Where a nitrogen fertilizer was used, it was placed around the hill in both methods of application of superphosphate and potash. As an average of 16 replications of the two methods of application, there was a

slight but insignificant advantage in favor of broadcast application.

Farmers' Meetings. Several farmers' meetings were held in August, at which time from 1200 to 1300 farmers visited the substation and inspected the work being done. Representatives were present from 26 western Kentucky counties and five states.

Personnel. The Experiment Station staff is given on page 3 of this report. The appointments and resignations for the year follow:

Appointments:

Harvey Cunov, assistant bacteriologist. February 1.

Miss Statie Erikson, head of the department of home economics. February 1.

Wesley Brooks, field agent in cream grading. February 21.

Miss Genevieve Farwell, technician. April 15.

H. Bruce Price, head, department of markets and rural finance. May 1.

Robert K. Calfee, assistant chemist. June 4.

W. A. Price, head, department of entomology and botany. September 1.

Clifton J. Bradley, assistant in markets. September 1.

Miss Ruth Boyden, assistant in home economics. September 9.

R. E. Culbertson, assistant in agronomy. October 1.

Encil Deen, inspector of feeds and creameries. November 20.

C. J. Maupin, field agent in poultry improvement. November 1.

Resignations:

Miss Mariel Hopkins, head of department of home economics. February 1.

George F. Insko, field agent in cream grading. February 21.

E. C. Johnson, assistant in markets. September 10.

Transfer:

R. E. Proctor, field agent in farm management, to Agricultural Extension Division.

New Projects. Summer and winter cover crops and fertilization for peach orchards.

A study of the income and expenditures of farm families.

A rural home management study.

Pasture experiments. Western Kentucky Substation.

Comparison of superphosphate, finely ground rock phosphate, and low-phosphorus open-hearth basic slag. Western Kentucky Substation.

Experiments on lime and fertilizer requirements and methods of fertilizer application on the soils of sandstone origin of the Western Kentucky Substation.

Fertilizer tests on potatoes.

Planting date for second-crop potatoes.

A comparison of earliness and yield of Northern and Kentucky-grown strains of Irish Cobbler potato.

Publications:**Bulletins:****No.**

291. Calcium metabolism in the laying hen. III. Calcium carbonate and hatchability. G. Davis Buckner, J. Holmes Martin and A. M. Peter. January, 1929.
292. Systems of farming for the Purchase Region of Kentucky. J. B. Hutson, W. G. Finn and Z. L. Galloway. February, 1929.
293. Leafhopper injury to clover and alfalfa. H. H. Jewett. March, 1929.
294. Feeding trials with laying hens. J. Holmes Martin and W. M. Insko, Jr. April, 1929.
295. Commercial feeds in Kentucky in 1928. J. D. Turner, H. D. Spears, W. G. Terrell and L. V. Amburgey. May, 1929.

- 296. Bacillary white diarrhea and related diseases of chickens. P. R. Edwards and F. E. Hull. September, 1929.
- 297. Potato fleabeetles. H. H. Jewett. October, 1929.
- 298. Analyses of commercial fertilizers. H. E. Curtis, H. R. Allen and Lelah Gault. December, 1929.

Reports:

- Forty-first annual report of the Experiment Station—1928. Thomas Cooper.

Scientific Papers:

- Mosaic control in Mexico. W. D. Valleau. *Phytopathology*, vol. 19, 1929.
- A note on the blackstem disease of alfalfa, sweet clover and red clover. W. D. Valleau and E. N. Fergus. *Phytopathology*, vol. 19, p. 507, 1929.
- Breeding diseases of the horse. W. W. Dimock. *Jour. Amer. Vet. Med. Assoc.*, vol. 74 (N. S. 27) No. 3, pp. 327-35 Feb. 1929.
- A fatal infection of chicks due to bacilli of the paratyphoid B group. P. R. Edwards. *Jour. Infec. Diseases*, vol. 45, No. 3, pp. 191-5, 1929.
- The Kentucky marl beds as a source of lime material. S. C. Jones. *Jour. Amer. Soc. Agron.*, vol. 21, No. 4, pp. 392-98. April, 1929
- Rate of feather growth in Barred Plymouth Rock chickens. J. Holmes Martin. *Poultry Sci.*, vol. 8, No. 4, pp. 167-83, April-May, 1929.
- The chlorate method for the determination of nitrate nitrogen, total nitrogen and other elements in soils and plant tissues. E. M. Emmert. *Jour. A. O. A. C.*, vol. 12, No. 2, pp. 240-247, May 15, 1929.
- Shortening the time of nitrogen determinations by the use of the grid burner. H. D. Spears and W. G. Terrell. *Jour. A. O. A. C.*, vol. 12, No. 2, pp. 250-51, May 15, 1929.

- Effect of excessive dosages of thyroid on the domestic fowl. J. Holmes Martin. Biol. Bulletin, Vol. 56, No. 5, pp. 357-70, May, 1929.
- Relationships among the encapsulated bacilli, with especial reference to *Bact. aerogenes*. P. R. Edwards. Jour. Bact., vol. 17, No. 5, May, 1929.
- The hydrogen-ion concentration of the reproductive organs of the White Leghorn chicken. G. Davis Buckner, and J. Holmes Martin. Amer. Jour. Physiol., vol. 89, No. 1, pp. 164-69, June, 1929.
- Calcium and phosphorus metabolism of the growing chick. G. Davis Buckner and J. Holmes Martin. Poultry Sci., vol. 8, No. 5, p. 284-89. July 1, 1929.
- A sheep dipping vat. J. B. Kelley. The Sheepman, p. 6. July-Aug. 1929.
- The transmission of bacillary white diarrhea among hens. P. R. Edwards and F. E. Hull. Jour. Amer. Vet. Med. Assoc., vol. 75 (N. S. 28) No. 3, pp. 333-36, Sept. 1929.
- The determination of nitrate in green tomato and lettuce tissues. E. M. Emmert. Plant Physiol., vol. 4, No. 4, pp. 519-28, Oct. 1929.
- The relative utilization of certain calcium compounds by the growing chick. G. Davis Buckner, J. Holmes Martin and W. M. Insko, Jr. Poultry Sci., vol. 9, No. 1, p. 1-4. Nov. 1, 1929.
- The slide agglutination test in the detection of bacillary white diarrhea. P. R. Edwards and F. E. Hull. Jour. Amer. Vet. Med. Assoc., vol. 75, (N. S. 28) No. 5, Nov. 1929.
- The constancy of the agglutination test in the detection of bacillary white diarrhea. P. R. Edwards and F. E. Hull. Jour. Am. Vet. Med. Assoc., vol. 75, p. 765, Dec. 1929.

FINANCIAL STATEMENT

In Account with the United States Appropriations, 1928-1929.

	Hatch Fund	Adams Fund	Purnell Fund
Receipts from the Treasurer of the United States, as per ap- propriations for fiscal year ended June 30, 1929, under acts of Congress approved March 2, 1887 (Hatch Fund), March 16, 1906 (Adams Fund), and February 24, 1925 (Purnell Fund)	\$15,000.00	\$15,000.00	\$50,000.00
Expenditures:			
By salaries	14,920.85	14,611.30	39,856.10
Labor		164.57	2,380.38
Stationery and office supplies ..		2.50	96.55
Scientific supplies, consumable ..		21.01	467.52
Feeding stuffs		7.00	521.63
Sundry supplies			47.51
Fertilizers			
Communication service			51.32
Travel expenses	79.15	7.24	2,664.10
Transportation of things		4.94	36.41
Publications			1,817.68
Heat, light, water and power....			
Furniture, furnishings, fixtures ..			1,540.24
Library		6.44	210.07
Scientific equipment			239.39
Livestock		175.00	
Tools, machinery and appli- ances			71.19
Buildings and land			
Contingent expenses			
Balance			
Total	\$15,000.00	\$15,000.00	\$50,000.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Kentucky Agricultural Experiment Station for the fiscal year ended June 30, 1929; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was none on the Hatch Fund and none on the Adams Fund and none on the Purnell Fund; that the receipts for the year from the Treasurer of the United States were \$15,000.00 under the act of Congress of March 2, 1887, \$15,000.00 under the act of Congress of March 16, 1906, and \$50,000.00 under the act of Congress of February 24, 1925, and the corresponding disbursements \$15,000.00, \$15,000.00, and \$50,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, leaving balance of \$ none, \$ none, \$ none, respectively.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, March 16, 1906, and February 24, 1925, and in accordance with the terms of said acts, respectively.

Signed:

THOMAS COOPER,
D. H. PEAK,
WELLINGTON PATRICK,
Auditors.

Seal of
Institution.
Attest:

ELOISE GALLOWAY,
Custodian of the Seal.

For the Year 1929

Compiled from the Records of the U. S. Weather Bureau Station, Lexington, Ky.

ANNUAL METEOROLOGICAL SUMMARY

Month	Temperature, Degrees Fahrenheit				Precipitation, in Inches				Wind				Number of Days															
	Maximum	Mean		Extreme	Relative Humidity Per cent 7 a. m.	Total	Maximum in 24 hours.	Date	Total Snowfall, Inches	Per cent of Sunshine	Average Hourly Velocity	Prevailing Direction	Maximum For 5 mins.		Gales, 33 miles per hour or over	Clear	Partly Cloudy	Cloudy	Precipitation of .01 inch or more	With trace or more of snow	Thunderstorms	Dense fog	Max. Temp.		Min. Temp.			
		Date	Minimum										Direction	Velocity									Direction	Date	Time			
																										Freezing or below	Freezing or above	Freezing or below	Freezing or above
January	42.0	21.9	32.0	72	18	2	13	85	2.83	0.92	24-25	2.8	29	13.7	SW	48	SW	18	19	15	12	1	2	0	9	26	0	
February	36.9	21.5	29.2	59	26	0	10	74	3.37	1.34	25-26	12.5	43	10.1	SW	36	SW	26	12	12	9	0	1	0	10	22	1	
March	58.6	40.2	49.4	86	25	15	7	73	3.67	1.29	4-5	7.5	59	14.6	SW	42	W	16	9	13	2	0	0	0	8	10	0	
April	67.8	47.8	57.8	83	7	35	2	74	3.09	0.81	8-9	T	47	14.7	SW	52	W	1	5	16	0	0	0	0	0	0	0	
May	71.6	52.8	62.2	88	30	33	3	77	5.59	1.45	12-13	T	47	11.7	SW	46	SW	2	3	11	1	6	1	0	0	0	0	
June	80.4	60.7	70.5	90	22	42	3	82	5.59	1.95	†	0	67	9.6	SW	35	NE	20	4	11	13	0	10	0	1	0	0	
July	84.4	65.5	75.0	92	28	52	15	77	4.25	1.22	5	0	63	9.4	SE	32	NW	1	2	11	13	0	11	0	1	0	0	
August	82.5	62.3	72.4	93	1	54	20	80	2.24	0	23-24	0	67	9.5	SE	38	N	23	1	4	11	0	11	0	2	0	0	
September	77.3	59.1	68.2	90	2	40	19	82	7	1.49	1.39	23-24	0	63	9.4	SE	38	N	23	1	4	11	0	11	0	2	0	
October	63.0	47.2	55.1	75	16	32	24	79	4.35	1.42	8	T	54	9.7	SW	24	N	23	0	5	0	3	0	0	0	0	0	
November	48.5	35.0	41.8	69	12	3	30	90	2.99	1.48	21	T	26	10.7	SW	56	NW	22	1	7	13	0	1	1	0	4	10	
December	43.8	28.8	36.3	65	12	-2	3	89	3.92	1.53	3.2	5.6	34	13.5	SW	38	NW	18	1	17	14	10	1	0	11	17	1	
The Year	63.1	45.2	54.2	93	1	-3	30	82	41.45	1.95	Jul 1	22.6	47	11.6	SW	56	NW	Nv			151	40	8		9	34	84	4

†Jun. 30-July 1.

MONTHLY AND ANNUAL MEAN TEMPERATURE

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann.
1872	30	35	42	53	66	74	75	74	67	53	37	27	
1873	30	35	42	53	66	74	75	74	67	53	40	39	54.0
1874	36	38	44	46	66	77	78	75	71	57	45	38	56.0
1875	27	29	42	49	64	72	76	71	64	52	43	43	52.7
1876	41	39	41	52	65	72	77						
1887											44	35	
1888	31	36	41	56	63	72	76	74	63	51	46	37	54.0
1889	37	32	46	55	63	69	75	72	65	52	43	50	55.0
1890	44	45	39	56	63	77	76	71	67	56	49	37	56.6
1891	37	41	40	57	62	76	73	73	72	55	43	43	56.0
1892	28	41	39	54	63	76	75	75	68	57	41	33	54.1
1893	23	36	43	57	61	72	79	74	70	57	43	37	54.4
1894	38	34	49	54	62	75	76	76	71	58	41	37	55.9
1895	28	23	43	56	62	75	73	76	73	52	45	37	53.7
1896	34	35	38	62	71	72	75	75	67	54	48	38	55.9
1897	30	37	48	53	59	72	76	74	72	64	46	37	55.7
1898	28	36	49	50	65	74	76	76	72	56	43	33	55.8
1899	34	24	42	56	67	75	77	77	68	61	48	33	55.1
1900	36	31	39	55	66	72	77	79	73	65	45	37	56.3
1901	34	29	44	49	63	74	80	74	67	58	40	31	53.6
1902	32	25	45	53	68	71	77	74	67	59	53	34	54.8
1903	32	36	50	53	68	68	77	74	70	57	40	28	54.4
1904	30	31	46	48	64	72	74	74	69	57	44	34	53.5
1905	24	25	49	54	66	72	75	74	68	55	44	35	53.5
1906	37	32	36	57	64	72	74	76	71	55	45	36	54.5
1907	40	32	52	45	59	69	76	73	68	53	42	37	53.8
1908	33	33	50	55	65	72	76	75	72	58	48	38	56.1
1909	37	41	43	54	62	73	73	74	66	53	53	28	54.6
1910	32	31	54	54	59	69	75	73	70	60	40	29	53.7
1911	38	40	43	52	70	74	76	76	72	58	40	41	56.6
1912	23	28	39	57	65	69	75	72	70	59	44	36	53.1
1913	42	33	44	53	65	73	78	77	69	56	49	38	56.5
1914	37	29	40	54	66	76	78	75	67	59	46	30	54.6
1915	32	40	36	59	62	70	74	70	70	60	49	36	54.8
1916	40	33	41	52	67	69	78	76	67	58	47	34	55.2
1917	35	32	44	54	57	70	74	74	67	50	44	25	52.3
1918	20	38	49	52	69	72	73	79	62	61	44	43	55.2
1919	37	36	46	54	62	76	79	74	72	64	45	31	56.3
1920	30	33	45	50	62	71	74	72	70	62	43	36	54.1
1921	37	38	55	58	65	76	80	75	73	57	48	39	58.4
1922	33	38	47	57	68	75	75	75	73	61	47	39	57.3
1923	39	32	43	53	63	74	77	74	69	56	45	45	55.8
1924	30	33	39	55	58	73	73	75	64	62	45	34	53.5
1925	33	42	47	59	60	76	75	76	76	50	43	32	55.8
1926	32	37	37	49	65	69	77	76	72	57	41	35	53.8
1927	33	43	48	55	63	69	75	70	72	61	50	35	56.2
1928	33	36	42	51	62	67	76	75	64	61	45	39	54.2
1929	32	29	49	58	62	71	75	75	68	55	42	36	54.2

TEMPERATURE EXTREMES

Month	Highest	Year	Day	Lowest	Year	Day
January	72	1929	18	-14	1918	12
February	75	1918	28	-20	1899	13
March	86	1929	25	-1	1873	4
April	90	1925	24	15	1875	18
May	93	1911	28	30	1876	1
June	99	1914	27	40	1910	3
July	102	1901	22	51	1891	9
August	100	1918	6	46	1915	31
September	99	1925	9	32	1899	30
October	89	1919	2	21	1925	29
November	78	1895	7	-3	1929	30
December	71	1875	31	-9	1917	1

MONTHLY AND ANNUAL PRECIPITATION

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann.
1872											1.21	3.30	
1873	2.53	4.05	3.73	2.89	6.05	4.49	3.37	2.94	1.60	5.47	1.92	4.48	43.52
1874	5.41	4.89	5.90	6.81	0.79	3.55	6.26	1.57	2.89	0.92	4.27	3.83	47.09
1875	2.61	3.12	6.18	2.06	2.43	4.16	11.24	0.62	1.72	2.37	5.87	3.68	46.06
1876	6.06	1.66	3.63	4.20	2.16	4.13	3.84						
1887											3.02	2.71	
1888	4.39	2.93	5.82	3.17	3.29	2.97	4.21	8.76	1.22	3.02	5.15	1.88	46.81
1889	5.66	1.78	1.63	1.52	3.53	3.49	5.82	1.15	6.79	3.06	5.34	1.73	41.50
1890	5.34	8.13	9.91	3.59	4.71	7.43	3.14	7.32	1.82	2.38	3.54	4.05	61.36
1891	4.70	4.36	7.63	1.85	1.17	5.33	3.23	6.48	1.26	1.33	5.35	2.82	45.51
1892	2.35	3.10	4.01	6.57	5.32	3.81	6.22	3.28	4.10	0.45	3.72	3.03	45.96
1893	2.10	4.44	3.30	5.81	3.88	4.24	3.11	1.86	2.25	5.59	3.36	2.61	42.55
1894	3.58	3.35	2.13	4.19	3.81	4.44	0.87	3.67	4.05	1.40	1.88	3.45	36.32
1895	5.60	0.52	2.79	3.17	4.05	2.93	5.07	1.56	0.33	1.28	2.52	5.50	35.32
1896	1.25	3.15	5.41	0.40	3.20	3.74	10.39	3.37	4.25	1.27	4.30	2.56	43.29
1897	2.59	6.33	6.55	5.80	4.48	4.77	4.34	3.21	0.80	0.38	4.83	5.11	49.19
1898	9.56	2.20	8.18	3.29	6.13	7.94	5.72	2.99	3.55	5.27	2.89	2.80	60.52
1899	6.69	2.84	8.61	2.16	3.63	2.55	0.97	4.18	1.90	2.09	1.70	2.92	40.14
1900	2.13	3.17	1.98	1.23	3.54	2.19	2.80	5.75	1.85	0.79	6.38	1.86	33.67
1901	1.49	0.62	2.23	4.52	2.67	3.70	2.61	3.74	2.18	1.33	3.73	3.50	30.32
1902	4.77	0.90	2.92	1.27	2.43	5.19	2.33	1.89	2.60	2.11	3.09	6.60	36.10
1903	1.68	6.16	3.24	3.29	1.75	2.71	2.62	1.49	0.81	2.12	2.84	1.99	30.70
1904	1.92	2.38	4.75	3.08	2.60	2.51	3.13	2.44	1.71	0.57	0.53	3.10	28.72
1905	2.04	2.13	5.87	2.87	5.54	3.31	4.94	4.11	3.20	3.45	3.58	4.13	45.17
1906	2.29	1.84	6.45	1.11	3.15	4.68	3.89	4.92	5.03	0.74	3.95	4.54	42.59
1907	9.06	1.89	4.13	1.83	3.89	3.65	4.42	2.07	2.72	2.76	2.67	2.28	41.37
1908	1.85	4.81	8.17	4.99	4.20	2.12	3.60	2.98	0.38	0.72	1.65	2.13	37.60
1909	3.35	6.86	3.97	6.72	4.15	5.41	5.98	1.26	4.88	2.05	1.96	2.77	49.36
1910	4.46	4.11	0.46	4.22	6.24	5.92	7.66	4.15	7.92	1.67	1.72	2.81	51.34
1911	2.44	2.21	2.31	4.46	1.07	3.01	0.92	2.84	4.37	3.67	3.84	6.20	37.34
1912	1.78	2.50	4.36	6.89	5.11	2.15	4.70	3.23	2.09	0.51	1.02	3.66	38.00
1913	10.35	2.61	6.04	2.41	4.32	3.29	2.43	1.00	1.76	3.40	4.00	2.74	44.35
1914	2.50	3.87	2.24	2.23	1.65	4.77	2.63	4.69	1.82	5.32	1.62	4.40	37.74
1915	4.38	1.12	1.49	0.65	7.23	3.20	5.72	6.03	3.74	0.81	3.90	6.67	44.94
1916	5.65	3.40	3.30	1.01	2.92	5.33	1.72	2.34	2.75	2.04	1.25	3.63	35.34
1917	5.67	2.12	5.48	3.97	3.51	3.54	2.80	1.94	2.46	2.36	1.03	1.97	36.85
1918	4.46	1.92	1.55	2.09	4.13	3.61	2.91	2.68	1.41	4.57	2.24	4.83	35.50
1919	2.48	1.61	3.71	3.51	6.38	4.49	2.28	2.39	1.12	7.95	8.50	6.70	51.12
1920	5.26	2.11	4.62	6.42	2.51	2.39	1.73	6.71	4.88	2.75	2.22	1.40	43.00
1921	3.24	2.62	5.06	3.28	1.60	2.16	1.04	3.88	5.10	2.46	6.89	5.74	43.07
1922	1.87	3.12	7.75	4.46	3.10	2.44	2.13	2.20	5.99	1.25	0.88	5.67	40.86
1923	6.63	4.40	4.65	5.43	1.66	3.55	5.01	4.02	1.51	0.56	2.71	6.50	46.63
1924	5.00	2.60	2.42	3.75	3.04	4.04	2.77	2.28	3.89	0.11	1.32	5.59	36.81
1925	3.41	3.02	3.45	2.49	3.56	3.96	3.63	1.15	1.70	5.83	4.52	0.80	37.52
1926	4.43	2.27	2.52	1.54	2.06	2.78	5.95	7.03	4.04	7.46	3.21	4.32	47.61
1927	6.53	1.87	5.17	3.89	5.76	2.14	2.95	2.09	2.29	1.65	4.88	3.64	42.86
1928	2.68	2.30	2.67	2.79	2.12	10.62	5.16	4.30	0.71	2.69	3.79	1.92	41.72
1929	2.83	3.37	3.67	2.99	5.59	4.25	4.12	1.49	4.35	2.99	3.92	1.88	41.45

EXTREMES OF PRECIPITATION AND WIND

Month	PRECIPITATION			WIND			
	Greatest in 24 hrs.	Year	Day	Max. Vel.†	Dir.	Year	Day
January	3.50	1913	11	52	w	1928	24
February	3.04	1909	23-24	49	sw	1890*	25
March	3.61	1913	25-26	55	sw	1919	17
April	3.24	1909	29-30	52	sw	1909*	29
May	2.61	1898	6-7	52	sw	1924	24
June	5.50	1928	28-29	49	n	1890*	29
July	4.02	1875	11-12	52	nw	1929	1
August	2.98	1915	1-2	58	s	1918	6
September	5.45	1922	3	55	w	1899	14
October	2.32	1893	3-4	41	nw	1904*	21
November	3.95	1919	26-26	51	nw	1929	27
December	3.63	1919	6	49	sw	1895*	26

*Also in subsequent years.

†Basis of 3-cup anemometer.

